ISSN (print) 0093-4666 © 2012. Mycotaxon, Ltd. ISSN (online) 2154-8889

MYCOTAXON

http://dx.doi.org/10.5248/121.53

Volume 121, pp. 53–62 *July–September 2012*

Notes on some Eurasian species of *Anthracoidea* and *Entyloma*

Kyrylo G. Savchenko[1,2*], Vasyl P. Heluta[2], Ivan S. Hirylovich[3], Solomon P. Wasser[1,2] & Eviatar Nevo[1]

[1]*Department of Evolutionary and Environmental Biology and the Institute of Evolution, Faculty of Natural Sciences, University of Haifa, Mt. Carmel, Haifa 31905, Israel*
[2]*M.G. Kholodny Institute of Botany of the National Academy of Sciences of Ukraine, 2 Tereshchenkivska St., Kyiv 01601, Ukraine*
[3]*Belorusian State University, 4 Nezavisimosti Av., Minsk 220030, Belarus*
* Correspondence to: *savchenko.kyryll@gmail.com*

Abstract — New records of smut fungi representing *Anthracoidea* and *Entyloma* from Israel, Belarus, Kyrgyzstan, and Russia are presented. Each record is followed by a comprehensive description and illustrations based on original material. Additionally, a revision of *Entyloma*/*Ranunculus* records from Israel is given.

Key words — *Anthracoideaceae*, biodiversity, *Entylomatales,* Middle East

Introduction

Five new records of *Anthracoidea* species are reported, three for Belarus, one for Kyrgyzstan, and one for Russia; and three new records of *Entyloma* species, one new for Belarus and two for Israel. In addition, records of *Entyloma* on *Ranunculus* in Israel are revised.

Materials & methods

Sorus and spore characteristics were studied using dried herbarium material. The specimens were examined by light microscopy (LM) and scanning electron microscopy (SEM).

The sorus structure was studied under a Carl Zeiss Stemi Dv4 stereo microscope. For light microscopy (LM), spores were mounted in lactic acid, gently heated to the boiling point and cooled, and then examined at 1000× under a Carl Zeiss Axiostar light microscope. LM photographs were taken with a Canon Power Shot G10 camera. At least 50 spores were measured from each collection, and the variation is presented as a range, with extreme values given in parentheses. In the descriptions, mean and standard deviations (SD) calculated from spores measured in all specimens are listed after spore size ranges. For scanning electron microscopy (SEM), spores were attached to metal stubs by double-sided adhesive tape and coated with gold. The surface structure of spores was

observed at 15 kV and photographed with a scanning electron microscope JEOL JSM-6700F. Specimens used in this study are stored in the Herbarium of Haifa University (HAI), Herbarium of the Hebrew University of Jerusalem (HUJ), National Herbarium of Ukraine (KW), and HeKS, a personal, working collection of Kyrylo Savchenko.

Taxonomy

Anthracoidea angulata (Syd.) Boidol & Poelt, Ber. Bayer. Bot. Ges. 36: 23 (1963) Figs. 1–2

Sori in the ovaries of the inflorescences, forming black, globose, subglobose bodies around the achenes, 2–3 μm in diameter, dusty on the surface. Spores medium-sized, flattened, medium reddish brown, angular, irregular, elongated, (15–)17–20(–22) × 13–19(–20) μm [av. ± SD, 18 ± 1.5 × 16.5 ± 2 μm]. Spore wall evenly to unevenly thickened, ca. 1.2–2.5 μm thick, thickest at the angles, usually with several protuberances, light refractive spots and internal swellings; surface finely verruculose with densely situated, rounded warts. Spore profile wavy.

Distribution: Europe, Asia.

Specimens examined: **BELARUS**. Minsk region, Minsk district, near Volchkovichi, oak-grove, 20.VII.2005, on *Carex hirta* L., leg. I.S. Hirylovich (HAI 2864, HeKS 223); Smolevichi district, forest near Zhazhelka, 25.VII.2005, on *C. hirta*, leg. I.S. Hirylovich (HAI 2865). Mogilev region, Osipovichi district, near Daraganovo, on the railway embankment, on *C. hirta*, 18.VIII.2010, leg. I.S. Hirylovich (HAI 2866).

Note: *Anthracoidea angulata* is a new species for the Belarusian mycobiota.

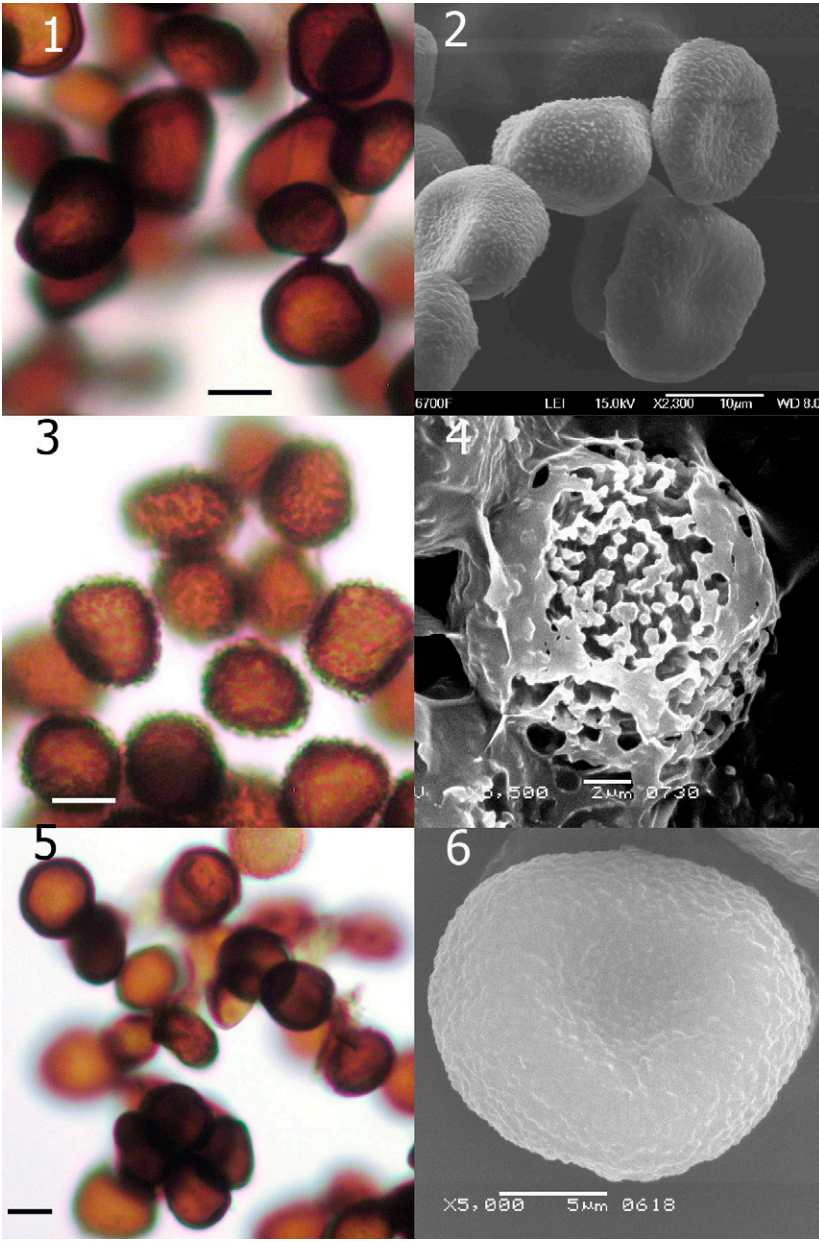
Anthracoidea echinospora (Lehtola) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 72 (1963) Figs. 3–4

Sori in the ovaries of the inflorescences, forming carbonaceous, globose, subglobose bodies around the achenes, 2–3 μm in diameter, covered by a thin silvery-greyish membrane; during maturation the spore mass cracks down. Spores small, flattened, olivaceous-brown to brown, subglobose, ovoid, irregular, sometimes elongated, (12–)13–20(–22) × (11–)12–15(–17) μm [av. ± SD, 16 ± 2.5 × 13.4 ± 2.1 μm]. Spore wall evenly thickened, ca. 1 μm, without any light refractive spots or internal swellings; surface echinate with irregularly dispersed, apically enlarged and flattened, often confluent spines ≤ 1.5 μm high. The wall between the spines striate-rugulose; the base of the warts longitudinally crumpled. On the tips of the warts the remnants of a thin membrane cover some parts of the spore surface.

Distribution: Europe, Asia.

Specimen examined: **BELARUS**. Gomel region, Zhlobin district, near Zhlobin, on *Carex acuta* L., 18.VII.2009, leg. I.S. Hirylovich (HAI 2867, HeKS 224).

Note. *Anthracoidea echinospora* is a new species for the Belarusian mycobiota.



Figs 1–6. **1–2**: spores of *Anthracoidea angulata* on *Carex hirta*. **3–4**: spores of *A. echinospora* on *C. acuta*. **5–6**: spores of *A. heterospora* on *C. nigra*. 1,3,5 = LM; 2, 4,6 = SEM. Scale bars: 1–3, 5 = 10 μm; 4 = 2 μm; 6 = 5 μm.

Anthracoidea elynae (Syd.) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 65 (1963) Figs. 7–9

Sori in the ovaries of the inflorescences, forming black, globose, hard bodies around the achenes, 1.5–2.5 mm in diameter, dusty on the surface, partly hidden by the perigynium. Spores medium-sized, flattened, medium to dark reddish brown, subglobose, disc-shaped, (15–)16.5–19.5(–20.5) × (13–)14–18(–19) µm [av. ± SD, 18.2 ± 1.6 × 15.9 ± 2.2 µm]. Hyaline sheaths on the flat sides of the spores present. Spore wall evenly thickened, ca. 1–2 µm thick, thickest at the angles, no light-refractive areas, internal swellings were not observed; surface almost smooth to finely verruculose on the flat side. Spore profile smooth.

Distribution: Europe, Asia, North America.

Specimens examined: **KYRGYZSTAN**. Issyk Kul Province, Ak-Suu district, near Karakol, on *Kobresia capillifolia* (Decne.) C.B. Clarke, 5.VIII.1933, leg. M.V. Klokov (KW 37520).

Note. *Anthracoidea elynae* is a new species for Kyrgyzstan.

Anthracoidea heterospora (B. Lindeb.) Kukkonen, Ann. bot. Soc. Zool.-Bot. fenn. 'Vanamo' 34(3): 63 (1963) Figs. 5–6

Sori in the ovaries of the inflorescences, forming black, globose, subglobose to ovoid bodies, 1–3 mm in diameter, powdery on the surface. Spores small, flattened, medium reddish brown, globose, subglobose, angular, (10–)12–19 (–21) × (10–)11–17 µm [av. ± SD, 16 ± 2.5 × 13.2 ± 2.1 µm]. Spore wall ca. 1–2 µm thick, thickest at the angles, usually with several internal swellings; surface finely and densely verruculose with densely situated, rounded, often confluent low warts. Spore profile slightly wavy.

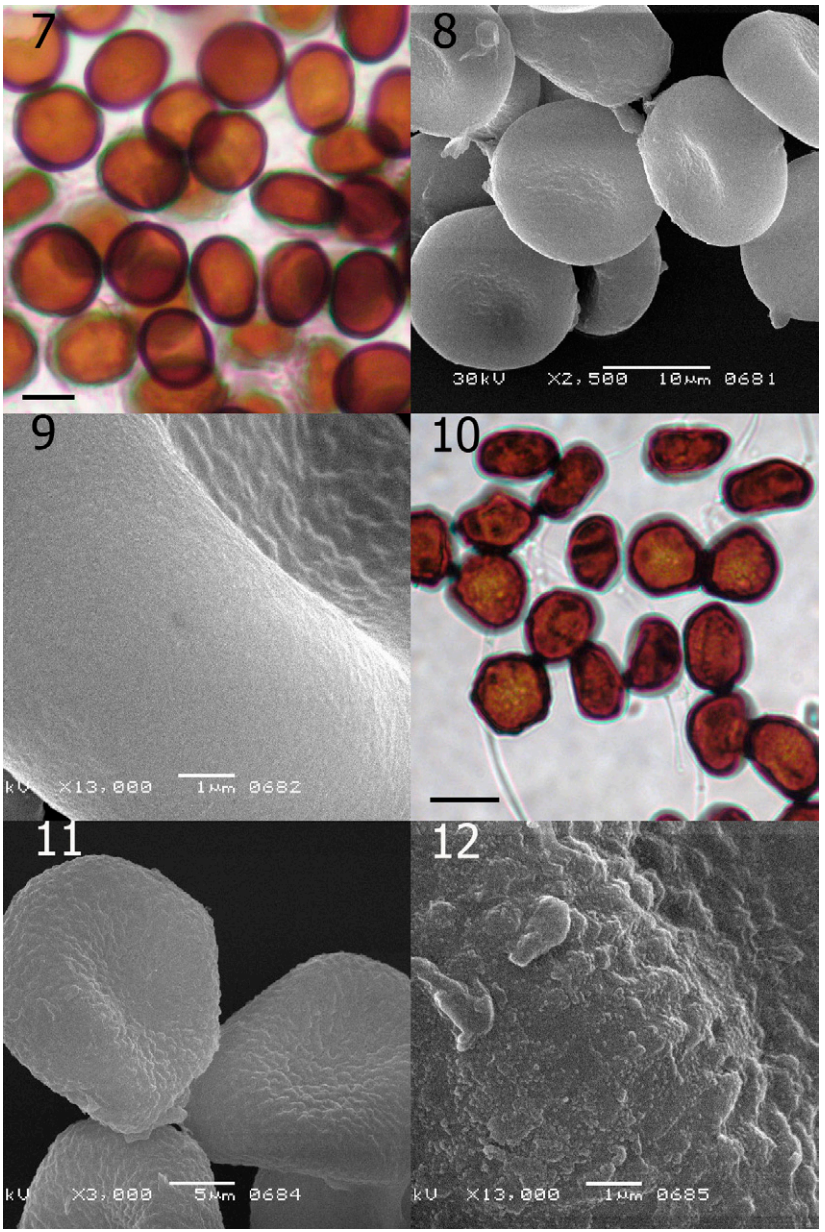
Distribution: Europe, Asia.

Specimens examined: **BELARUS**. Minsk region, Minsk district, near Zacep, 27.VII.2008, on *Carex nigra* (L.) Reichard, leg. I.S. Hirylovich (HAI 2871); Valozhyn district, near Krazhino, on the forest edge, on *C. nigra*, 22.VI.2005, leg. I.S. Hirylovich (HAI 2868, HeKS 225).

Note. *Anthracoidea heterospora* is a new species for the Belarusian mycobiota.

Anthracoidea tomentosae Vánky, Bot. Not. 132: 227 (1979) Figs. 10–12

Sori in the ovaries of the inflorescences, forming black, globose, subglobose, hard bodies around the achenes, 1–2 mm in diameter, when young covered by a white-silvery membrane; spore mass agglutinated to semi-agglutinated, partly hidden by the perigynium. Spores large, flattened, medium to dark reddish brown, subglobose, sub-angular, irregular, (19–)21–27(–28) × (14–)15.5–22(–24) µm [av. ± SD, 23.5 ± 2.3 × 18.1 ± 2.6 µm]. Spore wall unevenly thickened, ca. 1.5–2.5(–3.5) µm wide, thickest at the angles, usually with several protuberances, light refractive spots and internal swellings sometimes present; surface finely punctate-verruculose with densely situated,



Figs 7–12. **7–8**: spores of *Anthracoidea elynae* on *Kobresia capilliformis*. **9**: spore surface of *A. elynae* on *K. capilliformis*. **10–11**: spores of *A. tomentosae* on *Carex tomentosa*. **12**: spore surface of *A. tomentosae* on *C. tomentosa*. 7, 10 = LM; 8, 9, 11, 12 = SEM. Scale bars: 7, 8, 10 = 10 µm; 9, 12 = 1 µm; 11 = 5 µm.

often confluent, 0.2–0.5 μm high, rounded warts. The spaces between the warts minutely verruculose. Spore profile serrulate.

Distribution: Europe, Asia.

Specimen examined: **RUSSIA**. Krasnodar Krai, Gelendzhik district, near Kabardinka, on *Carex tomentosa* L., 15.VI.1986, leg. N. Chernov (KW 37611).

Note. *Anthracoidea tomentosae* is a new species for the Russian mycobiota.

Entyloma ficariae A.A. Fisch. Waldh., Bull. Soc. nat. Moscou, Biol. 52: 309 (1877) Figs. 13–15

Sori (Fig. 13) in leaves as flat, round, or angular spots, 2–7 mm in diameter, first white, later pale creamy-brown. Spores (Figs. 14–15) globose, subglobose, ovoid, (11–)12–15(–16) × (9–)10–13(–15) μm [av. ± SD, 14 ± 2.1 × 11 ± 1.8 μm], subhyaline. Spore wall even, smooth, ca. 1–2.5 μm thick. Anamorph present on both sides of leaves.

Distribution: Europe, Asia, Africa.

Specimen examined: **ISRAEL**. Golan Heights, Hermon National Park, 400 m northeast from Neve Ativ, 1180 m. alt., 32°26′45″N 35°74′83″E, on *Ranunculus ficaria* L., 26.IV.2011, leg. K.G. Savchenko (HAI 2863, HeKS 228; GenBank JQ586199).

Note. *Entyloma ficariae* is a new species for the Israeli mycobiota.

The closely related *E. majewskii* Vánky & M. Lutz is also distributed in the Irano-Turanian floristic region, particularly in Iran, but differs from *E. ficariae* by thicker spore walls (≤ 7 μm), the absence of the anamorph, and bullate rather than flattened sori (Vánky & Lutz 2010). Molecular analyses confirmed the assignment of the specimen from Mount Hermon to *E. ficariae.*

Entyloma gaillardianum Vánky, Mycotaxon 16: 104 (1982) Figs. 19–21

Sori in leaves, as rounded, circular spots, 1–5 mm in diameter, or larger by confluence, first pale yellowish-green, later brownish-green, with a thin yellowish margin around the spots. Spores globose, subglobose, irregular, subhyaline to lemon yellow, 10–14 × 9–13(–14) μm [av. ± SD, 12.5 ± 1.6 × 11.4 ± 1.4 μm]. Spore wall 2-layered, ca. 1–3 μm. Spore surface smooth.

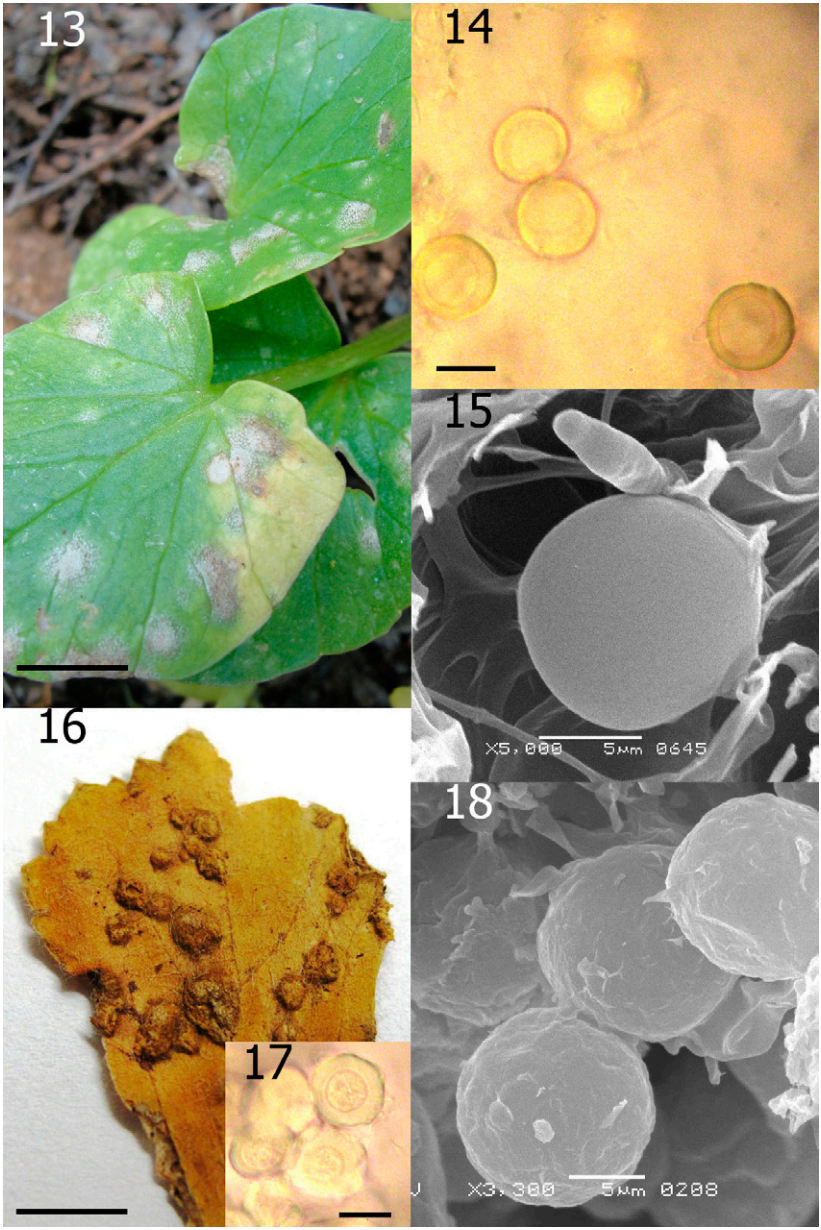
Distribution: worldwide.

Specimen examined: **ISRAEL**. Upper Jordan Valley, Tiberias, 20.IV.2005, on cultivated *Gaillardia aristata* Pursh, leg. S. Voytyuk (HAI 2869, HeKS 229).

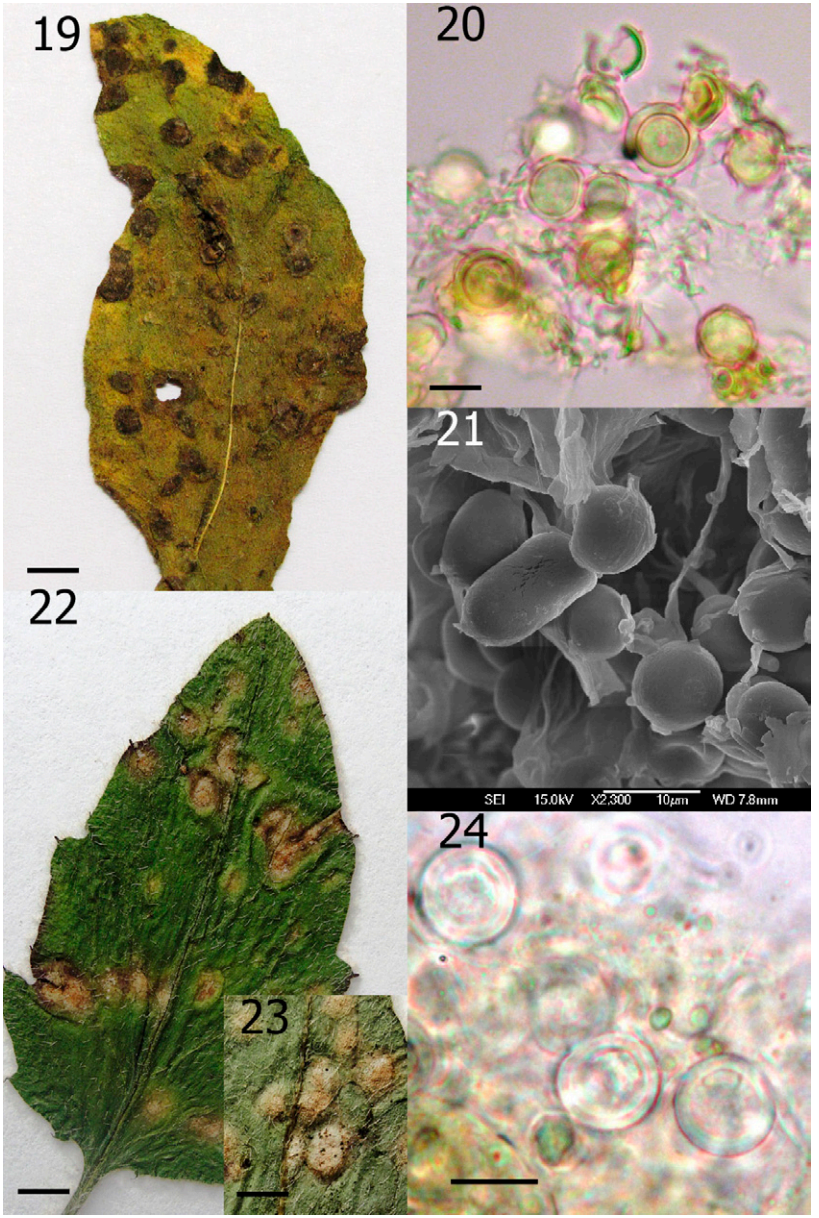
Note. *Entyloma gaillardianum* is new for the Israeli mycobiota and probably was imported into the country with *Gaillardia* plants.

Entyloma hieracii Syd. & P. Syd. ex Cif., Bull. Soc. Bot. Ital. 1924: 50 (1924) Figs. 22–24

Sori in leaves, as rounded, angular spots, 1–7 mm in diameter, first pale yellowish-white, later yellowish-brown, with a thin pale green margin around



Figs 13–18. **13**: sori of *Entyloma ficariae* on *Ranunculus ficaria*. **14–15**: spores of *E. ficariae* on *R. ficaria*. **16**: sori of *E. microsporum* on *Ranunculus asiaticus*. **17–18**: spores of *E. microsporum* on *R. asiaticus*. 14, 17 = LM; 15, 18 = SEM. Scale bars: 13, 16 = 5 mm; 2, 3, 5, 6 = 5 µm.



Figs 19–24. **19**: sori of *Entyloma gaillardianum* on *Gaillardia aristata*. **20–21**: spores of *E. gaillardianum* on *G. aristata*. **22–23**: sori of *E. hieracii* on *Hieracium sylvularum,* adaxial and abaxial sides respectively. **24**: spores of *E. hieracii* on *H. sylvularum*. 20, 24 = LM; 21 = SEM. Scale bars: 19 = 10 µm; 20, 21, 24 = 10 µm; 22 = 4 mm; 23 = 3 mm.

the spots. Spores globose, subglobose, irregular, sub-hyaline to yellow, (9–) 10–15(–16) × 8–12(–14) µm [av. ± SD, 12.3 ± 2.5 × 9.9 ± 1.9 µm]. Spore wall even, ca. 1–3 µm wide. Spore surface smooth.

Distribution: Europe, Asia, North America.

Specimen examined: **BELARUS**. Minsk region, Minsk district, near Volchkovichi, oak-grove, on *Hieracium sylvularum* Boreau, 20.VII.2005, leg. I.S. Hirylovich (HAI 2870, HeKS 230).

Note. *Entyloma hieracii* is a new smut fungus for the Belarusian mycobiota, and *H. sylvularum* is a new host for this species.

Entyloma microsporum (Unger) J. Schröt., in Rabenhorst, Fungi Europ. Exsicc. no. 1872 (1874) Figs. 16–18

Sori in leaves, as wart-like swellings, different in shape, 1–5 mm in diameter, first yellowish-white, when dry adaxially brownish, abaxially ocher-brown, swollen, with cracked surface. Spores densely situated, globose, subglobose, irregular, subhyaline to light yellowish, (12–) 14–19(–21) × (10–)12–17(–18) µm [av. ± SD, 16 ± 2.1 ×15 ± 1.8 µm], with granular matrix. Spore wall 2-layered, with yellow, even, ca. 0.5 µm thick inner layer, and hyaline, uneven, ca. 1–6 µm thick outer layer. Spore surface smooth, often covered by separated remnants of spore walls.

Distribution: worldwide.

Specimens examined: **ISRAEL**. Samaria, Wadi Fedjaz, 24.II.1957, on *Ranunculus asiaticus* L., leg. A. Grizi (HUJ); Upper Galilee, Mount Meron (= Mount Jermak), on *R. asiaticus*, 27.II.1951, leg. C. Rayss (HUJ, as *E. ranunculorum*).

Note. This taxon has previously been recorded from Israel under the names *Entyloma microsporum* and "E. *ranunculorum*" (Rayss 1952, 1959; Savchenko et al. 2010). Although the invalid name "*E. ranunculorum*" Liro is usually equated with E. *ranunculi-repentis* Sternon (Vánky 2011: 201–202), accurate microscopical examination of soral structure and spore morphology indicated that the Mount Meron collection should be assigned to *E. microsporum*. The Mount Meron collection has smaller spores [(12–)12.5–17(–18) × (10.5–) 11–16(–17) µm] with thinner walls [1.5–5 µm], compared with the Samaria collection [(13–)13.5–19.5(–21) × (11–)13–17.5(–18) µm, with 2.5–6 µm walls].

Acknowledgments

We thank Matthias Lutz and Marcin Piątek for peer-reviewing the manuscript, Matthias Lutz for confirming our identification of *Entyloma ficariae* with molecular methods, Shaun Pennycook for a number of useful corrections, curators of the herbaria HUJ and KW for loaning specimens, and Vitalii Sapsai for help with the SEM microscopy.

Literature cited

Rayss T. 1952. Etudes de quelques Ustilaginées récoltées en Palestine. Palestine Journal of Botany Jerusalem Series 5: 229–236.

Rayss T. 1959. Quelques additions à la mycoflore d'Israel. Bulletin Research Council of Israel 8D : 1–14.

Savchenko KG, Heluta VP, Wasser SP, Nevo E. 2010. Smut fungi of Israel: a preliminary check-list. Mycologia Balcanica 7: 111–116.

Vánky K. 2011 ("2012"). Smut fungi of the world. American Phytopathology Society, St. Paul MN. 1458 p.

Vánky K, Lutz M. 2010. *Entyloma majewskii* sp. nov. (*Entylomataceae*) on *Ranunculus ficaria* from Iran. Polish Botanical Journal 55(2): 271–279.